1. Investigation of sensitivity of the simulation model

Antecedent: I set up a general aerodynamic model based on the literature :

$$C_L = C_{L0}(\alpha, V) + C_{L\dot{\alpha}} \cdot \frac{\dot{\alpha}}{V/l_\mu} + C_{Lq} \cdot \frac{q}{V/l_\mu} + C_{L\dot{q}} \cdot \frac{\dot{q}}{V^2/l_\mu^2}$$

$$C_D = C_{D0}(\alpha, V) + C_{D\dot{\alpha}}(\alpha, V) \cdot \frac{\dot{\alpha}}{V/l_\mu} + C_{Dq}(\alpha, V) \cdot \frac{q}{V/l_\mu} + C_{D\dot{q}}(\alpha, V) \cdot \frac{\dot{q}}{V^2/l_\mu^2}$$

$$C_m = C_{m0}(\alpha, V) + C_{m\dot{\alpha}} \cdot \frac{\dot{\alpha}}{V/l_\mu} + C_{mq} \cdot \frac{q}{V/l_\mu} + C_{m\dot{q}} \cdot \frac{\dot{q}}{V^2/l_\mu^2}$$

1.1 I disclosed with the investigation of sensitivity of the above model, that the parameter C_{mq} has an important role in the dynamic behavior of the hang-glider.

1.2 I set up an applied aerodynamic model based on the results of the above investigation of sensitivity:

$$C_L = C_{Lst}(\alpha) + C_{LV} \cdot \frac{V - V_{st}(\alpha)}{V(\alpha)}$$

$$C_m = C_{mst}(\alpha) + C_{mV} \cdot \frac{V - V_{st}(\alpha)}{V(\alpha)} + C_{mq} \cdot \frac{q}{V/l_\mu}$$

$$C_D = C_{Dst}(\alpha)$$

2. Determining the deformation of the hang-glider

Basic assumption: I introduced the „flexible line” which is a suitable tool for simple modeling of the flexible behavior of the hang-glider can be.

2.1 With the help of the estimation method based on the above „flexible line” theory I disclosed that because of the deformations the negativ twist of the wing is increasing with increasing speed and constat AoA. The change in the twist causes a decrease of the lift coefficient and an increase of the momentum coefficient. The parameter C_{mq} is independend of this phenomenon.

2.2 The above described effect on the lift and momentum coefficients will be stronger with increasing AoA.

3. Parameter-space

Antecedent: I proved the behavior of the hang-glider by different values of the parameters C_{LV}, C_{mV} and C_{mq} with the aid of many simulation. (Parameter-space)

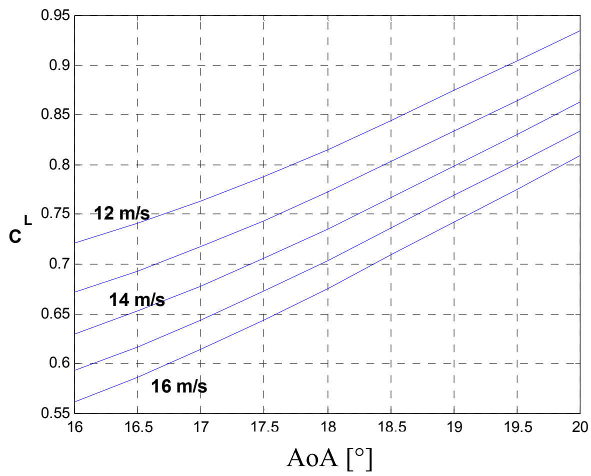
3.1 I specified based on the above simulations the values of the parameter C_{LV}, C_{mV} and C_{mq} wich cause the dangerous „tuck"-tendency of the hang-glider.

3.2 Based on the parameter-space and the deformation model it can be stated that the noseangle of the hang-glider is increasable along the increasing stiffness of the wingtube without any increase in the „tuck"-tendency.

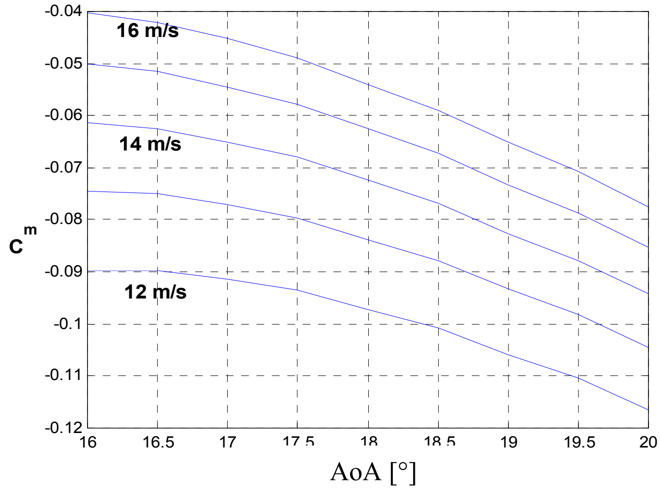
4. The values of the aerodynamic parameters

Antecedent: I measured the control force in dynamic flight along the AoA, speed, static pressure and angle of sideslip. I built an identification method based on the error function $E = \sum_{i=1}^{n} \left(\frac{\alpha_{sim,i} - \alpha_{meas,i}}{\alpha_{meas,i}} \right)^2 + \sum_{i=1}^{n} \left(\frac{V_{sim,i} - V_{meas,i}}{V_{meas,i}} \right)^2$ and the Nelder-Mead minimum finding method.

4.1 The values of the lift coefficient of the tested hang-glider was calculated over the alfa-V plane by the above introduced measurements and identification method. The surface of it can be described by the following curves:



4.2 The values of the momentum coefficient coefficient of the tested hang-glider was calculated over the alfa-V plane by the above introduced measurements and identification method. The surface of it can be described by the following curves:



4.3 The value of the parameter C_{mq} in the measured range of aoa and speed of the tested hang-glider: $C_{mq} = 1.14$ (constant).

5. Conclusions based on the direct analysis of the measured data:

5.1 I realized based on measured control force, aoa and speed that doesn´t appear any rapid change in the curves of the control force which would indicate stability or control problems.

5.2 The derivative $\frac{\partial K}{\partial \alpha}$ decreases with increasing aoa. This indicate a decreasing stability, but helps the special landing procedure of the hang-gliders.